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INTRODUCTION

Public health professionals have always been concerned with measuring the events of the life cycle—birth, infancy, childhood, adolescence, sexual maturity, and childbearing. Good health policy requires accurate, timely public health data, and public health planners need to know the data that are available and how to use that information. In turn, public health data systems need to respond to the needs of program managers and health planners by providing and interpreting numbers that can be translated into appropriate action. The demand for such information is rapidly increasing in the public health community and will become even more critical as the United States moves into the twenty-first century.

This monograph is a step toward making the surveillance systems of the Centers for Disease Control and Prevention (CDC) more accessible to persons concerned with the health of women, infants, and children. It describes the state of the art for surveillance at CDC and discusses applications of public health data. We hope that this monograph will aid health professionals in collecting, examining, and applying data to improve the health of women and children.

Early Health Data on Women and Children

In the latter half of the nineteenth century, scientists and clinicians interested in public health issues began to recognize the importance of collecting adequate data to address the health of American women and children. Infant death rates were considered a critical measure of the population's health in the general sanitation

reform movements that occurred in the United States and Europe during this period (1). One of the best known early U.S. reports on public health data was *Shattuck's Report of the Sanitary Commission of Massachusetts, 1850*, which described the health of the citizens of Massachusetts (2). This extensive report described infant and maternal mortality and recommended that public health programs conduct sanitary surveillance, immunization activities, and well-baby programs. The extremely high death rates among children of poor, urban immigrants also were of special concern, as described in the 1857 American Medical Association *Report on Infant Mortality in Large Cities, the Sources of Its Increase and the Means of Its Diminution* (3).

By the late 1870s, many city and state health departments were calculating the infantile death rate, a measure of the ratio of deaths to children <5 years of age to all deaths in the community (1). Health officials also were beginning to recognize the importance of distinguishing deaths among children <1 year of age from deaths among older children and of examining the seasonal changes in causes of death. These more precise data led to the identification of annual epidemics of summer diarrheal deaths among the youngest infants in urban environments. Reports of these epidemics, published each summer in city newspapers, drew public attention to the influence of environment and nutrition on infant health. By the 1890s, these concerns had led to the operation of hygienic milk stations by private philanthropists and city

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health departments to provide safe milk for urban infants (1,4).

At the turn of the century, the U.S. Bureau of the Census began publishing national census data that included infant mortality rates and covered 41% of the national population (5). Fifteen cities reported infant mortality rates of >200 deaths per 1,000 live births. In 1906, a summary of causes of infant deaths from 1900–1904 reported that the most common causes were “digestive and diarrheal diseases,” “congenital problems,” and “respiratory disease” (6). These rates were based on estimates of the numbers of live births (although births were registered in a number of cities, a national birth-registration area was not established until 1915). In 1908, the New York City Health Department established a Division of Child Hygiene, one of the first city bureaus of child health in the country. The division’s early programs used the city birth register to identify every newborn in a Lower East Side health district and then send a public health nurse to teach new mothers appropriate infant care (4). Four years later, the federal Children’s Bureau was created in the Department of Labor with the primary responsibility of studying and reducing infant mortality (7).

During the second decade of the twentieth century, health professionals became increasingly aware that protecting the health of pregnant women might significantly improve infant health, and prenatal care became a more popular concept. The importance of prenatal care was emphasized in 1913 with the publication of the first national reports of neonatal deaths. This information from the 1910 census described infant deaths occurring within 1 day, 1 week, 1 month, and 1 year of birth (8). “Premature birth,” “congenital debility,” and “malformations” were reported as the top causes of death in the neonatal period, whereas “diarrhea and enteritis,” “respiratory disease,” and “premature birth” were the overall most common causes of death in the first year of life. These reports illustrated that neither clean milk nor maternal classes on infant care would address a large portion of the causes of infant mortality, and that clinicians needed to pay greater attention to the health of the mother

before the infant’s birth. That same year, the Children’s Bureau published the first edition of its pamphlet, *Prenatal Care* (9).

The Children’s Bureau encouraged birth registration and also conducted a series of community evaluations, beginning in 1913, to examine the determinants of infant mortality. These evaluations included the recording of all infant births and deaths, household surveys to interview the families of these infants, and the collection of standardized data on community sanitation, civic organization of the community, and economics. These survey data confirmed the distribution of causes of infant death that were being reported by the census bureau and provided quantitative evidence of the effect of long-suspected risk factors—such as age, parity, and family income—on the survival of infants (1,7).

During World War I, interest in children’s health increased with the recognition that disturbingly high numbers of American draftees were not healthy enough for military service. The Children’s Bureau identified 1918 as “Children’s Year” and used the special event as an opportunity to convince state legislatures to improve birth registration, create divisions of child health, and expand well-baby and prenatal care in urban and rural settings. Maternal mortality also gained greater public attention. In 1917, the Children’s Bureau submitted a report to Congress on *Maternal Mortality from All Conditions Connected with Childbirth in the United States and Certain Other Countries*, stating that in 1913, maternal mortality was the second most common cause of death (after tuberculosis) among females aged 15–44 years (10). By 1920, the health of pregnant women and the health of their infants were considered linked in public health programs for maternal and infant welfare.

Women and children’s health was further bolstered after the Great Depression’s effects on the welfare of families led to the passage of the Social Security Act of 1935. This act provided for state maternal and child health services, or Title V programs. Over the succeeding decades, this act served as a source of federal support for state health programs, and, at times, for

research into women and children's health (1). More recently, the Omnibus Budget Reconciliation Act of 1989 linked the use of Title V funds to state assessment and reporting requirements, increasing states' focus on the use of women and children's health data.

Shortly after World War II, the concept of public health surveillance became embodied in the Communicable Disease Center, the precursor agency of the Centers for Disease Control and Prevention (CDC) (11). Over the past 40 years, CDC's surveillance activities—initially oriented to a few infectious diseases—have expanded to encompass both emerging infectious diseases and numerous noninfectious causes of morbidity and mortality among women and children. The Cutter vaccine incident of 1955—when vaccine contaminated with live polio virus caused polio among newly vaccinated children—was an early indication of the importance of surveillance for a childhood illness and led directly to the formation of the poliomyelitis surveillance program at CDC. In 1957, the Public Health Service's Venereal Disease Division, with its emphasis on aggressive use of field data to control reproductive tract infection, was transferred to CDC.

CDC became responsible for the national polio immunization program in 1961, and the Vaccine Assistance Act of 1962 eventually provided funds for a major pediatric immunization and surveillance program covering polio, diphtheria, pertussis, tetanus, and measles. CDC programs in family planning and birth defects surveillance were also begun during the 1960s. The Public Health Service Ten-State Nutrition Survey of the late 1960s, which demonstrated that millions of U.S. children and young women were malnourished, signaled the beginning of CDC's pregnancy and pediatric nutrition surveillance activities in the 1970s.

In the 1980s, new CDC programs related to women and children's health have included the development of injury and violence surveillance systems, the emergence of acquired immunodeficiency syndrome as a major health concern, and the expansion of CDC to include the National Center for Health Statistics, with its

vital statistics and survey data. More recent CDC surveillance activities are described throughout this monograph, illustrating the continuing interaction among health trends, data collection resources, and public policy.

Modern Concerns About Women and Children's Health Data

The 10-fold to 100-fold decreases in infant and maternal mortality since 1900 are the results of twentieth century interventions to improve the health of women and children (12). Changes in the primary causes of infant deaths—from digestive and diarrheal diseases in 1900 to birth defects, sudden infant death syndrome, and preterm delivery in 1988 (12)—reflect innovative developments in medical therapy and public health practice. Nevertheless, the United States continues to have many of the serious discrepancies first identified in the 1850s—health differences between rich and poor, minority and white, and urban and rural populations. Infant and child mortality remains a core measure of our society's strengths and priorities. Similarly, for maternal mortality and morbidity in the United States and in the developing world, education and poverty remain important predictors of risk. High levels of unintended pregnancy, sexually transmitted diseases, and abortion in the United States illustrate the continuing need for society to address the health concerns of women throughout their reproductive years.

How does public health surveillance address these issues? In its 1988 report, *The Future of Public Health*, the Institute of Medicine recommends that “every public health agency regularly and systematically collect, assemble, analyze, and make available information on the health of the community, including statistics on health status, community health needs, and epidemiologic and other health problems.” This report emphasizes the need for data collection and analysis at local, state, and national levels (13). Most importantly, the theme of that report and this monograph is that community health data be used systematically to evaluate and improve health programs and policies.

Local and state health departments routinely examine information on the primary causes of mortality and morbidity and the populations at highest risk for these outcomes. They also provide health services and, increasingly, must evaluate these services—determining who needs health care, who is receiving services, and how effective are the services. To answer these questions, health departments must regularly collect, analyze, and interpret public health data. With Medicaid costs rising, state revenues decreasing, and health-care reform developing, the need to identify the most efficient and effective public health response in each community is more critical than ever.

For decades, the CDC has worked with state health departments in the surveillance and analysis of health data. Traditionally, this partnership has focused on examining infectious disease concerns. More recently, CDC has also assisted states in examining the epidemiology of noninfectious chronic diseases, injuries, and environmental health problems. Women and children's health focuses on a specific population rather than a specific disease or a bundle of diagnoses; it addresses major socioeconomic, cultural, and health system concerns. CDC programs approach this population from many directions—such as immunization, injury control, the monitoring and prevention of birth defects and developmental disabilities, family planning and prevention of adolescent pregnancy, and behavioral risk factor surveillance—reflecting the broad distribution of health problems and risk factors that affect women and children.

The use of epidemiology, data surveillance and analysis, and program evaluation has become an essential aspect of strong maternal and child health programs. The goal of this monograph is to describe the various surveillance activities and data collection systems at CDC that are relevant to the health of women and children. This information will be useful to state and local public health professionals, university maternal and child health educators, and others concerned with women and children's health. In addition to describing CDC's surveillance programs, we also discuss data interpretation issues and provide examples of how the data have been used effectively in public health practice.

SURVEILLANCE OF WOMEN AND CHILDREN'S HEALTH

What is Public Health Surveillance?

According to CDC's formal definition (14)—

Public health surveillance is the ongoing systematic collection, analysis, and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know. The final link in the surveillance chain is the application of these data to prevention and control. A surveillance system includes a functional capacity for data collection, analysis, and dissemination linked to public health programs.

In broad terms, public health surveillance is the monitoring of diseases, injuries and conditions for their frequency, risk factors, consequences, and health service requirements (15). This monitoring carries with it a responsibility for examining and interpreting the reported data, recommending and implementing public health action, and evaluating that action through continued surveillance. Ideally, all portions of the health system contribute to this cycle. The principles of public health surveillance are described elsewhere (16).

What events should have a high priority for surveillance? The numbers of affected individuals, the severity of the condition, the costs of the condition to society, the availability of preventive or curative treatments, and the importance of the event as a sentinel indication are all considerations in determining surveillance need (15). Health policy or public interest may emphasize the surveillance of events in special groups, such as minority or adolescent populations. These general surveillance concerns also apply to the surveillance of women and children's health. Many health events of special interest to maternal and child health programs are described in the Public Health Service's *Healthy People 2000* (17).

In establishing and maintaining surveillance systems at the local, state, or federal level, we

must consider several general feasibility issues, such as the quality of data, timeliness of reporting, confidentiality, and costs:

- The quality of data affects the conclusions that can be drawn, and frequently a trade-off must be made between the amount and accuracy of gathered data. To ensure good data quality, we must appropriately refine surveillance definitions, design data collection instruments, train data collectors, and supervise data entry activities.
- Timely availability of information is particularly important for public program planning. Provisional infant mortality rates, with a limited number of variables, are reported 3–4 months after the month of occurrence of the deaths. However, to analyze infant mortality patterns using extensive data from vital records, we must wait until the subsequent calendar year is completed and all children born in the first year have had time to reach 1 year of age. Thus, >2 years must pass from the birth of the first infant in the cohort year before a linked infant birth-death file can be prepared for analysis. In a recent feasibility study of the national linkage of infant birth-death files to Medicaid service files, Mamer estimated that with all systems operating at present efficiency, the earliest such a file could be available would be 5 years after the birth of the first infant in the study year (18).
- Data must be collected at the individual level to permit the linkage of information from one data set to another. Individual identifying information such as name, date of birth, and address are needed for successful linkage; however, the collection of these data increases concerns over confidentiality.
- The costs of the data collection system must be weighed against the program improvements that may result from more accurate and timely data (19). With limited resources, many public health programs have difficulty supporting data gathering and analysis activities while service needs remain unmet. Nevertheless, this service

obligation must be balanced with the recognition of the importance of quality, timely information for effective management of limited resources and for supporting budget justifications. Failure to establish coherent, consistent data systems retards a health department's ability to target programs effectively and to identify those activities that are not cost-effective.

Measurement Issues

Although feasibility issues exist for any women and children's health surveillance system, measurement issues are more specific to the defined purpose of each surveillance activity. These purposes may include questions related to level of use, risk exposures, health outcomes, health services use, and data linkages. Many of the measurement issues described here in general terms are discussed in relation to specific surveillance programs in other chapters in this monograph.

LEVEL OF USE

Health officials at the local, state, and national levels have certain common data needs, but they also may need to collect different types of information for health issues unique to their location. The importance of states' constitutional role in public health means that they need answers to questions regarding their local conditions. National data or data from other regions of the country may be limited in their relevance to local concerns. For example, national surveys frequently use the term "Hispanic" in describing ethnicity, without further delineation. Yet differences in neonatal and postneonatal mortality risks have been identified among Puerto Rican, Cuban American, and Mexican American populations (20). Nevertheless, national data are useful for comparisons with local data and can serve as a first step in assessment if local data are not available. The surveillance systems described in this monograph include discussions of whether data are available at the state level and how they have been used by health departments and other agencies.

RISK EXPOSURES AND HEALTH OUTCOMES

In establishing data surveillance and analysis systems, health officials must decide what exposures and outcomes need evaluation. *Healthy Communities 2000: Model Standards* (21) notes the importance of establishing community health status (outcome) objectives. This document suggests surveillance and data system goals that include the ability “to detect and monitor conditions contributing to morbidity and mortality in the community,” a concept that includes the measurement of risk exposures as well as health outcomes.

Exposures include preexisting conditions, such as diabetes, and risk factors, such as smoking, which can lead to a health condition. They also include factors, such as early prenatal care, which can protect against an adverse health outcome. Some important questions must be asked regarding the measurement of exposures: Will the system be able to identify the medical, demographic, and socioeconomic characteristics that put a community, family, or individual at a high risk for poor health outcomes? How accurate are measures of prenatal care, child day-care use, drug and alcohol use, immunization status, economic conditions, and other risk factors?

The examination of race and ethnicity as a health exposure requires special attention. The designation of race and ethnicity is often problematic, and definitions may vary from one data collection activity to another. Race is frequently a marker for a variety of cultural, economic, and medical factors, and these factors must be taken into account when assessing the effects of race on health outcomes. Following a 1993 CDC workshop on the use of race and ethnicity in public health surveillance (22), attendees recommended that all CDC surveillance reports that included analyses by race should indicate the reasons for measuring race and interpret the meaning of this variable. In keeping with this recommendation, many of the chapters in this monograph discuss the use of race as a variable in the various surveillance activities.

Outcomes may also be a variety of health events, such as deaths due to sudden infant death syndrome, or hospitalizations due to

preeclampsia. When measuring outcomes, health planners must also consider a number of questions: Can hospitalizations be counted? Are complications of labor and delivery recorded? Are all outpatient visits reflected in the data? Ideally, definitions of each exposure and outcome should be formally described and should be consistent throughout the surveillance period. The 1989 revision of the U.S. Standard Certificate of Live Birth is an example of recent attempts to increase states' collection of information on exposures and outcomes (23). The revised certificate gathers new information on exposures, such as medical and behavioral risk factors, and on outcomes such as abnormal conditions of the infant.

HEALTH SERVICES USE

The purpose of tracking health services usually is to address questions regarding the numbers of clients, the unmet need for services, and the effectiveness of the services provided. Frequently, measures of service use are not population-based but are drawn from clinics or health programs selected for administrative purposes. To determine the extent of need for services, and to compare services provided in the program with services delivered outside the program, health policy analysts may link program data to population information. Service-based data sets need to be evaluated to determine what population-based data are necessary to answer health policy questions regarding unmet service needs and the effectiveness of program services that are provided.

DATA LINKAGES

Linkages between health-risk or service data and population outcome data are useful for estimating unmet service needs and comparing health-care use and outcomes between health program recipients and other population groups. In establishing data linkages, the analyst must address concerns such as unique identifying information that permits person-specific linkage and delineation of family units so that maternal and child care service data can be linked. Data linkage has only recently become technically feasible with the availability of less expensive but powerful computer hardware and software. Health data can now be entered into personal computers at

local health departments and be transmitted electronically to mainframes at the state level for analysis. Linkages once handled manually can now be performed through automated linking protocols, so that linked data are produced faster and with less cost.

A number of reports have come from the linkage of population and program data sets. Yip, for example, linked Special Supplemental Food Program for Women, Infants, and Children (WIC) data from the Pediatric Nutrition Surveillance System (program services) and Tennessee birth certificates (vital records) to identify whether children at a high risk of nutritional deficiency were enrolled in WIC programs (24).

As was evident at the Maternal, Infant, and Child Health Programs Data Analysis and Tracking Approaches Conference in 1992, states are particularly eager to link data sets (Atrash HK, unpublished data, 1992). In fact, the need for linkage of records was mentioned by virtually every state. Emphasis was placed on linkages among WIC, vital statistics, Medicaid, and other data sources including the Community Health Services Information System, Integrated Services Information System, hospital discharge data, Pregnancy Risk Assessment Monitoring System, Pregnancy Nutrition Surveillance System, and census data. States also expressed interest in cross-agency linkages among health, education, hospital, criminal justice, motor vehicle, and social services agencies, as well as in linked birth and death records.

CDC DATA COLLECTION SYSTEMS

Public health data collection systems used at CDC include not only traditional public health case-finding, disease-reporting, and sentinel surveillance activities but also such important data sources as vital records, population surveys, and hospital discharge data (25) (the surveillance activities described in this monograph are presented by category in Table 1). Not all of these systems meet CDC's formal definition of surveillance, and not all of them were originally designed for public health surveillance. However, these systems can provide health planners with useful,

regularly updated information that will improve their ability to prevent and control health problems among women and children.

Vital Statistics Systems

Vital statistics systems are a type of population-based system. The current U.S. vital records system has many of the advantages of an ideal data system. It gathers individual-level data; permits aggregation from the individual to the community, state, and national levels; has consistent definitions across jurisdictions; provides enough identifying information to avoid duplication of records and permit linkage to other data systems. This system measures critical outcomes (such as births, deaths, fetal deaths, and abortions) and, for births and fetal deaths, provides enough exposure information to help identify people at high risk because of geographic, temporal, and personal characteristics. These substantial advantages, as well as this system's historical role, make vital records a strong base on which to build a coherent, responsive data system. Topics in this monograph drawn from vital records data include low birth weight and preterm delivery, maternal and infant mortality, and fetal deaths.

Despite these considerable strengths, the vital records system has disadvantages as well. Often the risk exposure information is not sufficiently detailed to assure specificity or program relevance. Vital statistics systems rarely provide adequate service use measures for the major service programs (e.g., WIC, Medicaid) or for private sources of health care. Beyond the birth period, these systems provide no measure of morbidity outcomes. Furthermore, vital records contain no information on costs of outcomes or services.

Vital records data and programs have several limitations. Serious concerns have been raised regarding data quality, especially for risk factor information, because the information is often gathered by persons untrained in systematic data collection. Timeliness may also be a concern because many months may lapse before all vital records are available on a birth cohort. Moreover, vital statistics programs require substantial resource investments in every state.

TABLE 1. Systems of collecting data for women and children's health — CDC, 1994

Vital statistics	Population surveys	Hospital discharge data systems	Disease-reporting and case-finding surveillance	Convenience and sentinel surveillance
Birth registration	National Survey of Family Growth	National Hospital Discharge Survey	Sexually transmitted diseases surveillance	Pregnancy Nutrition Surveillance System
Death registration	Pregnancy Risk Assessment Monitoring System	Birth Defects Monitoring Program	Abortion surveillance	Pediatric Nutrition Surveillance System
Fetal death reporting	HIV Seroprevalence Survey in Childbearing Women	Ectopic pregnancy and maternal morbidity surveillance	AIDS case reporting	HIV infection reporting
Linked birth/infant death database	Youth Risk Behavior Surveillance System		Pregnancy mortality surveillance	Gonococcal Isolate Surveillance Project
Current Mortality Sample (provisional)	National Maternal and Infant Health Survey		Metropolitan Atlanta Congenital Defects Program	
	National Health Interview Survey		National childhood lead poisoning surveillance	
	National Health and Nutrition Examination Surveys		Metropolitan Atlanta Developmental Disabilities Surveillance Program	
			National Bacterial Meningitis Reporting System	
			National Notifiable Diseases Surveillance System	

Population Surveys

Population surveys permit the assessment of key factors from all members of the population or from a representative sample. A sampling design is developed so that all members of the population have a known probability of being in the sample. Data may be collected through mailed questionnaires, telephone interviews, in-person interviews, or other approaches that permit data gathering on an individual level. Because the probability of being included in the sample is known for each individual, population surveys can be used to estimate the health experience of the entire population.

Among the important advantages of such surveys is that they provide information on the important risks and services affecting the entire population, including persons who use no health services or who obtain services in the private sector. These surveys also can directly provide data on overall population exposures, outcomes, and service needs. A variety of states have conducted population surveys to gather information needed for tracking and planning purposes. A national example of a population survey is the periodic National Maternal and Infant Health Surveys (formerly the National Natality Surveys), conducted most recently in 1988 by the National Center for Health Statistics.

Population surveys have several disadvantages related to linkage and feasibility. Frequently, direct linkage of data from surveys to individual data in other systems is not possible, because surveys are only a sample of the population and are often anonymous. Feasibility issues include the high costs of conducting such surveys. Although the data collected on interviewed individuals is often more complete and accurate than vital records data, conclusions may be inappropriate if many people refuse to participate in the survey (response bias). Such surveys also may miss rare events and may not provide sufficient data on population subgroups or small geographic areas. The timeliness of data collection and analysis may also be a problem.

Hospital Discharge Data Systems

Hospital discharge data systems provide estimates of the causes of major morbidity and mortality in the population. The National Hospital Discharge Survey, for example, provides population-based estimates of the numbers of Americans hospitalized each year as well as their medical diagnoses at discharge. The degree to which hospital admissions reflect the prevalence of a health event depends on the severity and emergency nature of the outcomes. For example, most fetal deaths in utero will require hospitalization of the mother, whereas early spontaneous abortions are less likely to result in hospitalization.

The advantages of these systems depend in part on how representative they are of all hospitalizations in a population. The National Hospital Discharge Survey is a population-based sample, and state-specific hospital discharge systems generally include most hospitals in the state. These systems can be used to estimate hospitalization rates of the entire population.

The disadvantages of hospital discharge data systems include the limited information provided for each patient—age, race, insurance, hospital length of stay, and diagnostic or procedural codes. Risk factor information important for public health purposes, such as the patient's smoking habits, are not included in these data. Because of confidentiality concerns, linking multiple records for the same

patient across different hospital admissions often is impossible. For example, a discharge data system may be used to report how many hospital admissions for infant injuries occurred in a year but not how many individual children were hospitalized for injury during that period.

Disease-Reporting and Case-Finding Surveillance Systems

Disease or injury reporting and case-finding systems are probably closest to the traditional image of public health surveillance programs. These systems are generally established, defined, and supported by a public health program and aim to capture all identifications of the health events of interest within specified geographic areas or reporting groups.

These reporting systems have sometimes been classified as passive or active, depending on whether public health personnel simply record voluntary reports of cases or actively search for cases through telephone calls to health providers or through other approaches. Data in these systems are collected in many ways and from a variety of sources, such as hospital records, laboratory reports, and school health documents.

One of the advantages of these systems is timeliness, because most of these surveillance systems are oriented toward early and regular reporting of health events. In addition, the quality of data may be very good if the system includes a major investment of resources in case-finding activities. Such systems usually have formal definitions for the health outcomes of interest, so the health events that are reported are accurately identified.

Many surveillance systems acknowledge that underreporting is a common problem. Another disadvantage may include cost, depending on the investment of public health resources in case-finding. In addition, confidentiality concerns may reduce the willingness of local health providers to identify cases for the surveillance—they may be concerned that their patients will be embarrassed or annoyed by contacts from the health department staff. Finally, information on

exposures may be limited, depending on the surveillance system's design. For example, race and ethnicity data are often not available in laboratory reporting systems.

Convenience Sample and Sentinel Surveillance

Convenience sample surveillance refers to examining a population that is readily accessible but not necessarily representative of the population of interest. Sentinel surveillance uses a similar approach; it is not based on a known probability system of sampling but on past experience that surveillance reports from a certain sample have provided a quick indication of health events in the general population. Some overlaps exist between these types of surveillance and the disease-reporting surveillance systems already described.

The Pediatric Nutrition Surveillance System and the Pregnancy Nutrition Surveillance System are examples of convenience samples that include pregnant women and children from public health programs that address the needs of low-income populations. Although accurate population rates of nutritional disorders cannot be obtained from these systems, they provide health policy makers with useful information on a large portion of low-income families in the United States.

The anonymous human immunodeficiency virus (HIV) seroprevalence surveillance of certain population groups, such as childbearing women, is an example of a sentinel surveillance system. When using these systems to make health policy decisions, we must assume that the data are a qualitative, if not a quantitative, representation of a broader population's health experience. For example, if the system detects increases in the frequency of a health event among the monitored population, we may assume that the same trend is occurring in populations that are not directly monitored, although the rate of the event in other populations is not known precisely. Sentinel surveillance activities traditionally serve as early warning systems—changes in health trends in these systems may indicate the need for short-term investment in more population-based (and more expensive) surveillance to address public health crises.

Advantages of these systems are low cost and timeliness, because they are specifically intended to be less expensive than a population-based approach and to provide data rapidly. The greatest disadvantages are usually the limited quality of the collected data and the fact that the information is not population-based. However, for certain sentinel events, such as childhood meningitis, even a few cases call for public health action, regardless of whether a population rate can be determined. Other drawbacks may include a paucity of exposure information and an inability to link this information to other data sets, although some convenience sample systems do provide detailed data.

CONCLUSION

One of the Children's Bureau's first steps in translating data into public health action was to prepare public information pamphlets on prenatal and infant care. From 1914–1921, almost 1.5 million copies of *Infant Care* were distributed to American women (26). In turn, women across the country sent the bureau honest, poignant letters describing their expectations and experiences with labor and delivery, child rearing and child loss, infertility, birth control, and a host of other reproductive and family health concerns. In 1921, a pregnant woman wrote for information to prepare her for her fourth delivery if the physician did not arrive in time, as had happened with two of her first three deliveries. Despite inadequate medical care, Mrs. M.A. of Minnesota was relatively lucky, as she notes of her third delivery (26):

Had no Dr. at all, but being a more experienced Mother and having my mother and a neighbor Lady with me, we got along fine. I have 3 boys. . . . Naturally, I am much interested in the things being done for children. I consider them the Nations most important asset. . . . In the course of a few years the Babies of today will be directing affairs. . . . I wish to say that I appreciate your work very much, tho I am only one of the many common-place "Ma's."

It is for the nation's most important asset, the mothers of today and their babies, that this monograph is written.

REFERENCES

1. Meckel RA. Save the babies: American public health reform and the prevention of infant mortality, 1850–1929. Baltimore, Maryland: The Johns Hopkins University Press, 1990.
2. Shattuck L. Report of the Sanitary Commission of Massachusetts, 1850. Facsimile ed. Cambridge, Massachusetts: Harvard University Press, 1948. Cited in: Meckel RA. Save the babies: American public health reform and the prevention of infant mortality, 1850–1929. Baltimore, Maryland: The Johns Hopkins University Press, 1990.
3. Reese DM. Report on infant mortality in large cities, the sources of its increase and the means of its diminution. *Transactions of the American Medical Association* 1857;10:102. Cited in: Meckel RA. Save the babies: American public health reform and the prevention of infant mortality, 1850–1929. Baltimore, Maryland: The Johns Hopkins University Press, 1990.
4. Rosen G. A history of public health. New York: MD Publications, 1958.
5. National Office of Vital Statistics. Vital Statistics of the United States, 1950, 2 vols. Washington, DC: US Department of Health, Education, and Welfare, National Office of Vital Statistics, 1954. Cited in: Meckel RA. Save the babies: American public health reform and the prevention of infant mortality, 1850–1929. Baltimore, Maryland: The Johns Hopkins University Press, 1990.
6. US Census Bureau. Mortality statistics, 1900–1904. Washington, DC: US Census Bureau, 1906. Cited in: Meckel RA. Save the babies: American public health reform and the prevention of infant mortality, 1850–1929. Baltimore, Maryland: The Johns Hopkins University Press, 1990.
7. Parker JK, Carpenter EM. Julia Lathrop and the Children's Bureau: the emergence of an institution. *Soc Sci Rev* 1981;55:60–77.
8. US Department of Commerce, Bureau of the Census. Mortality statistics, 1910. Washington, DC: US Department of Commerce, Bureau of the Census, 1913. Cited in: Meckel RA. Save the babies: American public health reform and the prevention of infant mortality, 1850–1929. Baltimore, Maryland: The Johns Hopkins University Press, 1990.
9. West MB Mrs. Prenatal care. In: Children's Bureau. Baby-saving campaigns. Washington, DC: US Department of Labor, Children's Bureau, 1913. Cited in: Meckel RA. Save the babies: American public health reform and the prevention of infant mortality, 1850–1929. Baltimore, Maryland: The Johns Hopkins University Press, 1990.
10. Meigs GL. Maternal mortality from all conditions connected with childbirth in the United States and certain other countries. Washington DC: US Department of Labor, Children's Bureau, 1917. Cited in: Meckel RA. Save the babies: American public health reform and the prevention of infant mortality, 1850–1929. Baltimore, Maryland: The Johns Hopkins University Press, 1990.
11. Etheridge EW. Sentinel for health: a history of the Centers for Disease Control. Berkeley, California: University of California Press, 1992.
12. NCHS, US Department of Health and Human Services. Vital statistics of the United States 1988. Vol II—mortality, part A. Hyattsville, Maryland: Public Health Service, CDC, 1991; DHHS publication no. (PHS)91-1101.
13. Institute of Medicine. The future of public health. Washington, DC: National Academy Press, 1988.
14. Thacker SB, Berkelman RL. Public health surveillance in the United States. *Epidemiol Rev* 1988;10:164–190.
15. Teutsch SM. Planning a surveillance system. In: Teutsch SM, Churchill RE, eds. Principles and practice of public health surveillance. New York: Oxford University Press, 1993.
16. Teutsch SM, Churchill RE, eds. Principles and practice of public health surveillance. New York: Oxford University Press, 1993.
17. Public Health Service. Healthy people 2000: national health promotion and disease prevention objectives—full report, with commentary. Washington, DC: US Department of Health and Human Services, 1991; DHHS publication no. (PHS) 91-50212.
18. Mamer J. Measuring prenatal care effectiveness: linking birth, infant death, and Medicaid files. Princeton, New Jersey: Mathematica Policy Research, 1992.
19. Thacker SB, Berkelman RL, Stroup DF. The science of public health surveillance. *J Public Health Policy* 1989;10:187–203.
20. Becerra JE, Hogue CJR, Atrash HK, Pérez N. Infant mortality among Hispanics: a portrait of heterogeneity. *JAMA* 1991;265:217–21.
21. American Public Health Association. Healthy communities 2000: model standards. Guidelines for community attainment of the year 2000 national health objectives. 3rd ed. Washington, DC: US Government Printing Office, 1991.
22. CDC. Use of race and ethnicity in public health surveillance. Summary of the CDC/ATSDR Workshop. *MMWR* 1993;42(No.RR-10):1–16.
23. Ventura SJ. Advance report of new data from the 1989 birth certificate. Hyattsville, Maryland: US Department of Health and Human Services, Public Health Service, CDC, NCHS, 1992. (Monthly vital statistics report: vol. 40, no. 12, suppl.)

24. Yip R, Fleshood L, Spillman TC, Binkin NJ, Wong FL, Trowbridge FL. Using linked program and birth records to evaluate coverage and targeting in Tennessee's WIC program. *Public Health Rep* 1991;106;176-81.
25. Stroup NE, Zack MM, Wharton M. Sources of routinely collected data for surveillance. In: Teutsch SM, Churchill RE, eds. *Principles and practice of public health surveillance*. New York: Oxford University Press, 1993.
26. Ladd-Taylor M. *Raising a baby the government way: mothers' letters to the Children's Bureau, 1915-1932*. New Brunswick, New Jersey: Rutgers University Press, 1986.

